9-25-59

MISCELLANEOUS NOTES AND SOME QUOTES FROM DISCUSSION ON TEM-A

Possible Problem also 60-day Programmer FFA

There was considerable discussion of the use of a printed circuit plate about 1/8 inch thick of plastic in place of the present combination of a 1/32" plate plus .010" spacer plus a 1/8 inch brass plate. For this combination of plates, we have gone inside the circuit area of the printed circuit plate to get proper hold down. This is to pull the 1/32 inch epoxy plate down against the brass plate since it is not structually strong enough to prevent warping.

For the new thick plate assembly, we would have to explore where we could get supporting posts up through the lower electronic circuit plate. We can find extra spaces for such a purpose even if we have to make slight re-arrangement of components and printed circuit.

The modules themselves are all metal and alignment of parts in modules is completely independent of bearing in the printed circuit plate. The hole in the printed circuit plate merely takes the center support of the total module so that it can be moved about this center to bring the contact fingers into their proper angular position. In other words, the bearing for the shaft which supports the rotating printed circuit disc is entirely independent of the epoxy printed circuit plate. If we had to, we could use screws recessed into the bottom of this printed circuit plate at points where we could not go all the way through if we would use the cementing in technique. The way some cements have worked on some of this work is so good that we are satisfied with it.

Our customer engineer did not see any reason why this single plate could not be substituted for the present combination and actually be preferable. It was agreed one should be made up before a quantity.

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"We have made temperature and lubrication tests on the watches. We have also made extensive tests on these modules before the total unit was completed. We have taken advantage of this module system as we have said before and have done considerable testing before the unit was ready."

There was a discussion on oils which brought out that the Anderson Oil Co. equivalent of 45X which is used on ETI's is Windsor lube L245X. On low temperature test down to 65° below the time values were quite satisfactory. This is on the watch module only. No lubrication is used on modules.

"About the only General Electric one we used is F50 as far as our test purposes go."

Did you actually check to see if there is any degraduation in timing at the high temperature?"

"I did, and there was very little change in timing. It is better at the higher than the lower temperature. At the high end, the lube viscosity is less and the motion goes up slightly. There is a slightly change in time

depending on whether the escapement unlocks just when the jewel pin on the balance wheel is going through the center position or whether it is slightly before or slightly after. If it is one direction, an increase in the motion will cause a decrease in the timing rate. On the other side, it would increase the timing rate. In other words, it is just a matter of seconds. It came out about 7 seconds per day."

"It is not like the effect that you get when you overbank. It is a different effect. It is pretty isochronous as long as you do not overbank or get down close to 12 degrees motion. 25X1

"That test result sounds pretty good."

We get down to -60° without serious degradation at -85° we are still able to start but will not continue to run for full minute.

If these devices are stored in cold storage to reduce the evaporation of lubrication in the watch, it may still be desirable (as is the case in watches supplied to the government,) to have them re-oiled after six months. In the discussion, it was indicated that the period is actually probably much longer than six months, but so far there is not sufficient data to say that you would get very reliable operation of watches which have been in storage for more than six months.

"Could you stand higher ampere hour drain to get batteries to work at lower temperatures? We would have probably have to go up at least 50% in drain to be sure we would not have trouble." 25X1

The resulting discussion was inconslusive.

The question was raised as to whether or not we have too much buckling in the 1/32 inch printed circuit plate fastened to the brass plate. It was pointed out that the amount of buckling that was seen on the top edge in the area adjacent to the TEM sweep would not have any measureable effect upon the sweep itself although the amount of buckling was greater than was expected.

It was suggested that we should have a shipping container which is more rugged than the plastic boxes we have been using. It should be dust tight, more like a wooden box for example. The comparison was brought out that a chronometer which is a much less expensive instrument than these are has a very much better looking shipping container or mounting box. The comparison breaks down somewhat in the fact that the outer case of the chronometer is actually to be used in service whereas the TEM unit has a complete cover without an outside box. Such a box will be designed in line with the desires of the customer.

discussed the general assembly and accessibility of the TEMA pointing out that all contacts are in a row for each disc so that it is readily evident that the contacts are properly aligned without the use of a separate disc such as was needed on TEM. Furthermore, the contacts are visible at the assembly after the assembly is complete. The mounting of all modules to the top plate makes it possible to lay back the upper portion of the system so that the contacts can be viewed from below to (continued on next page) 25X1

determine the cause of any trouble which may have developed. When viewed through the holes it is possible to make minor radial adjustments to the contacts with respect to the paths and to move the total module angularly to have the contacts fall in the proper portion of the individual segments.

The details of adjustment of the driving spring stroke, and detent, were also discussed. All of these adjustments are included in the adjustment specifications for the device which are being prepared for submission with the final report. It was pointed out that the ratchets are especially accurately manufactured and require real watchmaker's skill.

Sources of backlash were listed as being eccentricity of the ratchet gear, lack of uniformity in the teeth, method of assembly to hub. It was pointed out that some backlashes is necessary, perhaps, .002 inches on the outer edge of the disc.

It was requested that we put markers on each of the discs to indicate when the discs are in the zero position.

A simple test unit such as might be used by an assembler was demonstrated.

The question of total ampere hours taken by the TEMA was raised. Orginally the power allowed for TEM was 1 ampere hour for 60 days based on 1440 operations of the TEM sweep and once per minute operation of the selenoids for the calender. In going to the TEMA, the requirement for temperature and other requirements increased the total mechanical power which must be delivered so greatly that it was considered that two ampere hours should be allowed. However, by careful engineering of the transistor circuits which had to be used to take care of the temperature conditions involved, we have been able to keep the power down to approximately .7 ampere hour.

1 sweep per hour

The calculation to arrive at .6 or .7 AH does not make allowance for the fact that the shape of the current curve through the solenoids is such that its area (transient current times the time of the transient) is appreciably less than that of the square wave which was assumed in the calculation.

Several changes were discussed which might be made advantageously, such as bringing out the watch contact leads to the terminal board, and making the components circuit board two-sided.

On questioning it was pointed out that the thermistor shown in connection with the 10 cycle multivibrator is to obtain better temperature control of the frequency of this oscillator.

It was pointed out that the wire which we used in connecting from the upper printed circuit to the lower printed circuit is much heavier than it needs to be. It is no. 22 flexible and we eventually broke a wire because of the large number of times this was flexed in taking it apart. We have ordinarily used no. 30 which is much better for this particular place.

[redacted] discussed the resistance soldering method of application of the contact fingers to the upper printed circuit pointing out that we had done

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considerable experimenting on the time and voltage parameters involved and that this resistance soldering method gives a greater guarrantee of avoiding cold soldered joints when it is used properly than do any of the other usual methods.

A variation of the resistance soldering method is also used in connection with soldering the funelets into the printed circuit boards to give greater guarrantee of the connection of these points.

In spite of our preference for 2 oz. copper on the printed circuit because of the need to solder to the circuits, we feel at present that we must stay with the 1 oz. because of the greater difficulty in providing a flush circuit in the sweep sector area when a heavier copper is used.

Three methods of providing flush circuitry were discussed. (A) As used on a printed circuit disc, the plating is applied to a base first and the insulating of the disc formed above this. When the system is later stripped away from the base it is of course as flush and smooth as the mold to which it was applied. (B) The pressure temperature system in which a circuit board is made up by the usual etching process then by a combination of heat and pressure it is pressed into a flushed condition. This has two disadvantages. One is that the material can not be fully cured and still be properly pressed to get a flushed condition, which introduces a new variable as to how far it has been cured. Also, pressing the material down tends to distort the body of the material and cause warping in the area which received the extra pressure. Some manufacturers try to avoid this by pressing the whole board. (C) Flow flushing is used by some manufacturers, in which an epoxy is flowed on to the area which is to be flushed and then pressure and heat applied to give the smooth cured surface desired. After this has been done a thin film of epoxy which will exist on the conductive surfaces must be removed by abrasion in some manner. In spite of the apparent difficulty with this latter system, it does seem to be successful.

There was a discussion of the new method of applying the printed circuit discs to the shaft by press fit in place of the three screw arrangement used for holding it to the hub before. This was possible because the adjustment of the position of the disc after assembly is accomplished by moving the total module. The perpendiculary of the disc to the shaft is accomplished by care in the press fit work and the relation of the total assembly to the printed circuit is assured by a compartitively large distance between the two bearings on which the printed circuit disc and ratchet shaft turn. It was pointed out that the screw thread on the end of the printed circuit disc shaft which is used to pull the assembly together is a loose fit and does not enter into the alignment of the parts since this is accomplished by closely mating surfaces independent of the screw thread fit. The screw thread is locked with a plastic cement which can be broken loose to disassemble the parts even though it will withstand the forces expected with several 100% margin.

In evaluating the present design, we have not found any things which we would want to change radically if we were to make a quantity of these devices. There are minor changes which we would make which would decrease the cost of manufacture and we are providing two sets of drawings one of which will cover the device as it actually is and the other of which will show what we call a proposed design. There are actually no functional differences.

mating connector will be provided

It was considered not necessary to supply a cable for 163 because we do not know whether the unit will be used with SAD or not, and how far it will be from the point where the unit is to the point where you want the plug to connect in.

It is considered best to be able to see the balance wheel when the unit is completely assembled and even in its case. However, it was agreed that the motion of the balance, (or at least the fact that it is moving) can be detected with a Vibragraph or other watch timing mechanism after it is in the case and after you start it. Anything beyond motion (such as actually measuring motion) would have to be taken care of after it was taken out of the unit.

It was agreed that a hole should be provided in the bottom of the base plate of the unit itself so that the watch can be seen more readily than it is now on 163, but that we would not provide a window in the outside case.

DESICCANT

A small envelope desiccant holding about one, teaspoonful of material was shown. Our information indicates that the porosity of the envelope is such that dust which might come through it would not likely affect the proper operation of a watch. However, a method of mounting and using this envelope has not been worked out and would not provide an indicator except by opening the unit to observe it. We did not use the material when the unit was on a vibration table so we do not know what effect this would have.

oil - dust affecting watch operation

Drawings of a unit made by Culligan were shown. This unit is too large to use without a considerable increase in the volume of the TEMA. There was considerable discussion of methods of getting a unit in above the watch location, for example, and being able to take it out without disassembling the unit. Anything screwed into the side of the case above the watch would, of course, have to be removed before the unit was taken out of the case. It was suggested that there might be a decal or other marking at the location of the screws which take the case apart indicating that the desiccant assembly must be removed first.

It was not immediately evident that the desiccant assembly could be completely interlocked so that it was necessary to remove this unit before the screws are removed. A method suggested was to have an L shaped plate covering the screws and held down against the case by the screw-in desiccant unit. Such a device which could obviously be bent out of the way would not be a great deterrent to a determined desassembler! A desiccant was shown which is used by Bell & Howell in their aerial cameras.

The question was raised of having the desiccant container so disposed that when it was removed it would seal off the rest of the unit to prevent recirculation of moisture laden air into the unit. This would prevent losing the remainder of the dry nitrogen. It was indicated that this would be quite a problem and take an appreciable amount of space.

The question was raised of how much servicing should be done in the field because it would be difficult to saturate the field with enough TEM units to always have one to replace a defective one. It was considered that the stock of replacement units would quite possibly not be accessible to the point of trouble.

Various methods such as only using nitrogen flushing and assuming that the unit would be in a reasonably dry place when it was taken apart were discussed. There is a strong desire on the part of our customer for a desiccant unit even though it might cause an increase in the size of unit.

It was pointed out that we do not have information as to how well the desiccant takes up moisture at low temperatures.

There was a strong desire expressed for a unit which would have a visual indication of its condition. We would flush out the unit with nitrogen and seal it up, using the desiccant unit as a guarantee. With a reasonable sized unit you have a choice then when you take the unit apart of either replacing the cell completely and depending upon it to dry out the unit or, better would be to flush out the unit with nitrogen, look at the condition of the cell which is already in there, and replace it or not according to its condition.

We have not obtained any information on the relative effectiveness of such devices at room temperature and -40 degrees for example. If this action is similar to that involved in sending material into solution, then you might expect that the activity of the crystals in absorbing moisture might be cut in half for each reduction of 10°C in temperature. We do not have any definite figures on this.

It was suggested that unless there is some reason to expect an appreciable difference in the pressure inside and outside the case there would be no reason for any change of atmosphere. This change does not occur as readily as many assume for it has been found that silver parts such as pure silver contacts which are quite subject to tarnish when exposed to air can be protected very well for a period of months by merely wrapping them in sulphur free paper which prevents the appreciable circulation of air but does not remove them from an atmosphere which has some of these corrosion elements in it.

There was a discussion of the degree of leak and it was indicated that the "Sniffer" test would detect a flow of gas through an aluminum casting and we are not interested in that degree of sealing. Our customer engineer indicated and it seems to be a matter of what kind of servicing will be provided.

It was suggested that the nitrogen gas can be available in a small bottle under pressure so that it would not be difficult to flush out the unit at normal atmospheric pressure. We would ordinarily do it by drawing a vacuum on the unit twice, refilling with nitrogen both times, - the introduction of gas being through a screw hole. This does not completely eliminate all traces of air of course but makes the residule so low that we should not have trouble.

We will be given further information on desiccant units our customer know of.

We agreed we could combine altitude and splash tests by evacuating over water-immersed divice and then make provision for lifting the device out of the water before the vacuum is relieved in case there has been any evidence of leak. This would avoid the necessity of disassembling and cleaning out all moisture before trying to seal up by some better method. We have agreed that fungus protection will not be necessary so long as the neoprene used for gaskets and "O" rings is not fungus sensitive. (This has been checked ok) We should, however, check whether the plug which is used for the wires brought out of this unit into a cable is fungus resistant. This should be checked with Amphenol local representative. (Has been checked and is ok.)

There was some discussion of adjustments, then the following:

"It is not as simple to perform the operations of adjustment as it may seem, unless the personnel involved came in here for training. For example, the adjustment on the commutator on the watch is difficult and [redacted] who has worked on this very closely could not see any real good watch maker being able to adjust it without some special training." 25X1 25X1

"These men that they sent in here for training were not watchmakers. They were men who went over to [redacted] to learn some watchmaking techniques - they were smart men - technicians etc. " 25X1

"As we were discussing yesterday the fact is they are probably better than a watchmaker for this kind of work."

"It, (the watch commutator adjustment,) is in the specification but it is very difficult to put everything in words, - there are some techniques that just have to be learned through trial and error and experience."

"Some discussion indicated that the people already used on Project #69 are capable people for anything that is involved in a watch adjustment. We should plan, therefore, that someone would come in here to get trained particularly on #163. The adjustments on the commutators springs are partly used to control the action of the watch and this would have to be very carefully trained into whoever was to do maintenance work on the #163 units.

Our customer indicated that there would be less training necessary for the individuals who would work on the device than ~~was~~ the case on the TEM because of the module construction. This is certainly true and previous comments have

indicated the greater ease of adjusting the contacts. Replacing a contact should not be necessary. It is not a very simple problem, however. Gaining the advantage of having all contacts in line required sacrificing the post-mounting of contacts used on project #69, #74, and #160.

We are in the process of preparing specifications for the various operations required in assembly and maintainance of this device. It would be desirable for those who will work on this device to have training on it even though they have had training before on other devices of a similar nature.

Our customer engineers suggested the possibility of a plug connection for bringing the wires from the top terminal board to the terminal board on the electronic circuit. This should be considered, but it was pointed out that this introduces two extra points of pressure contact which we try to avoid. We do plan to use a smaller wire and a somewhat greater length of cable so that the cable can be arranged in such a way as to distribute the bending over a longer length of cable.

Our customer engineer suggested that there is a small molded cable in multiples of 4, 8, 12, and so forth wires which can be obtained for such a purpose and he will advise us of the name of the maker of this cable. (This is not the flat cable made by Sanders Associates. They do not expect to bend the cable a lot of times as we have had to do on this particular model in doing the development work.) A sample they have received which is reported to be about 1/4 (one quarter) inch in diameter contain 20 wires or more in a sort of interlocked braid construction. The size of wire in the cable was not stated.

It was indicated that the inside of the Amphenol plug is potted to make this assembly completely sealed.

It was indicated that the 13/0 watch used for the time base in TEMA has standard gear ratios except for the fact that the return spring for the solenoid which acts as the spring for the watch only drives the watch for one minute in place of the approximately 40 hours that would be produced by the usual barrel in the watch. The watch also differs in having a commutator for provision of the once - per - minute pulses to the calender system.

There was some discussion of the independence of the various modules, such as the complete watch and commutator assembly. These can be assembled by different persons and then brought together in final assembly after tests on the individual modules.

It was pointed out that we have incorporated in the printed circuit top surface, dotted lines which show where the various circuits which can not be seen are connected across the board so that it is possible to trace out the complete circuit by looking at the top of the board.

A numbering system has also been arranged such that any numbers which appear are the numbers of the Amphenol plug to which they are connected. Any letters which appear opposite a terminal apply to wires which go from the top

circuit to the lower circuit and connect to terminals down there which have the same letter designation.

We have also adopted Nomenclature for the solenoids which is in line with the standards now used in the radio industry. For example K is used for a selenoid or a relay with sub-scripts for relays of the same use and preceeding numbers or letters to indicate more nearly the function of this particular solenoid. For instance, SK would refer to a sweep solenoid and CK to a calendar solenoid.

It was indicated that the people who were sent here for training and have been servicing the project #69 programmer have been quite successful in finding troubles and correcting them. And the suggestion was made that with some additional training these people should be able to take over an additional responsibility for TEM.

We indicated that the nature of the operation of 69 required a perhaps somewhat more delicate adjustment of the contacts than would be true for project #163 since the operation of the contacts on 69 was a slow motion operation where ambiguities were possible if contacts did not exactly line up. The pulse operation on project #163 eliminates such ambiguities by making the motion from one position to the other a definite quick step which cannot occur at a time when you are trying to take a readout.

It was suggested that in case of accident to any contacts on the printed circuit board so that they had to be replaced our customer would have need for a fixture of the nature that we used in aligning and placing the contacts in the first place. It seemed probable that in replacing a single contact this might not be necessary but that in case a number were to be replaced the need for the fixture would be much greater.

There was considerable discussion of the tendency of contacts to "Creep" if they have been radically adjusted to get them into the position in which they are to be used. It was indicated that the methods of preventing this by proper bending and over bending are difficult to describe or explain in a specification and have to be passed on to another person through his being guided while he gets actual experience.

It was suggested that a complete top circuit might be provided as a spare part with all of the contacts properly mounted on it and packaged in such a way that they would not get damaged. It was also indicated, however, that this is such a complex and important part of the total device that we would be getting rather close to the point where it would pay to have a complete new device rather than such sophisticated spare parts.

It was agreed that a complete watch with commutator would be a logical spare part to have, partly because re-oiling and cleaning may be desirable after six months or 1 year service. The length of time which it would be advisable to permit a unit to operate without recleaning and reoiling cannot be predicted with the experience we now have with such devices under the operating conditions to which they will be exposed.

The question was raised of using a complete calendar module as a spare part. It was pointed out that a completely adjusted module with ratchet and disc could not be used since the disc has to be removed to assemble the module to the top circuit plate. In doing this, the adjustments are disturbed. Furthermore, it would probably be desired that the printed circuit disc which was used in this location be used with the module that you are replacing.

It would seem possible, however, to have a packaged spare module which has been assembled with its proper contact disc and then dissassembled and packaged to be held as a spare. When it was assembled as a module to the top plate it should be possible to get it back into the condition and adjustments which were made on it before shipment. Then all that would be necessary would be to adjust the position of the modules by the adjustments provided by the mounting screw to bring the contacts to the proper position on the printed circuit disc. This would not be a cheap operation but would provide replacements for the modules.

It was pointed out that you cannot directly replace a transistor for example in the 10 cycle multivibrator without "touching up" some other parts of the circuit and that we do not know whether the transistors have a life problem or not. We have been told by one distributor that the manufacturers of transistors request that all trnasistors not sold in six months be returned to them as a safety measure. They insist that this does not mean that they consider the transistors have a limited life but it is hard to see any other explanation for such a request. We, therefore, cannot say for certain that there will not be an aging problem. We have not noticed any degradation in transistors in circuit work that we have been doing in the last couple of years.

It was pointed out that our supplier of the 10 cycle multivibrators for project #160 has now told us that he is una le to supply them to meet the requirements to which he originally agreed. This indicates a critical nature of the device and while we feel we have obtained a less critical design for #163 we would not want to say that one transistor could be replaced by another without seeing whether some other changes are necessary in the circuit. Consequently, to get the accuracy which is needed here the circuits are to some extent adjusted to suit a particular transistor.

It was indicated by our customer that in other types of equipment they often hand pick the transistor to suit the circuit for which it is to be used. It is our opinion that this is not necessary in the amplifier circuits but may be necessary in the oscillator circuit to get the degree of insensitivity to temperature and battery voltage which we now have. We have provided a potentiometer to make some adjustment but this does not provide for the amount of adjustment which might be necessary to take care of changing transistors.

The suggestion was made of using some sort of embedding for the components.

The point was raised of the great risk in having service personnel attempt to make repairs to a device which is as complex as this one and has very stringent adjustment requirements. We raised the question of whether the time required in locating the trouble and making the change might not be greater than the time required to get a complete new device from some central point to the point where trouble has developed.

A serious question was raised as to the time required to diagnois a trouble and then correct it with spare parts which might be on hand.

It was pointed out to our customer that in another application in which we must have a very certain source for our solenoids independent of the known variations in mercury batteries, we have planned to provide a heavy condenser as the power source and charge this at a slow rate from the mercury battery. By this means we will always have the power available for our pulse operation independent of any heavy pulses which might be drawn by some other load from the same battery. These other loads would be isolated by the charging resistor we use. Recognizing that this does waste approximately 1/2 the energy we consider it worthwhile in that particular case.

This type of arrangement could be built up for use with TEMA for special cases in which it is considered that an environmental condition would make the mercury battery or other small sized battery an unsatisfactory primary source for the operation of the solenoids.

Our customer expressed a desire for information on the tests we made and results we got - temperature and vibration - for comparison with tests which will later be made by their laboratory.

It was pointed out that no lubrication is used except on the watch.

Our customer will get us information on materials which have been used for embedding components on to boards such as our electronic circuit board. We have experimented with some ourselves but have a serious question whether many of these materials might have a vapor when they are in an enclosed space which might cause trouble with watch parts or contacts such as has been experienced sealed relays in many cases.

FINAL REPORT

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"It would seem to me that in your final report you could refer to things in the previous reports discussed in great detail like the method of lubricating watches, and tests made on lubricating watches so long as we did not omit anything that the man would need in connection with that unit.

"You could get a report that would be terrific and hardly readable. For instance, in one of the first reports you had on #74 - when we first were working on this thing. I did quite a write-up on various methods of binary counting and so on. Now later we only referred back to that because we figured that most of the people (especially an engineer) would know about binary counting and know what methods were available. We refer to 1-2-4-8 system from here on.

"Some judgement has to be used, of course." After some discussion of the project #74 report, it was stated that it was not too voluminous.

We have planned to supply with the contract the necessary drawings and information including test procedure and adjustment procedures, - all the information for people who are reasonably expert to properly assemble and check out this device.